CERTIFICATION OF TRANSLATION

I, Etienne MASSE, of CABINET PLASSERAUD, 65/67 rue de la Victoire, 75440 PARIS CEDEX 09, FRANCE, do hereby declare that I am well acquainted with the English language, and attest that the document attached is a true verified English translation of the text of the International Patent Application no.PCT/FR 04/03130.

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Heat exchanger comprising cleaning means

The present invention relates to heat exchangers, also called condensers, and more particularly to means for cleaning them.

A condenser comprises an enclosure provided with a plurality of tubes inside which a heat-transfer fluid circulates exchanging heat with a hotter surrounding medium (generally steam coming from a turbine of a power station, which steam, upon contact with the colder tubes, condenses on them thereafter to be conveyed to a collecting well).

The heat-transfer fluid conveys spherical cleaning bodies, hereafter called balls, which clean the internal walls of the tubes of the condenser in order to prevent them becoming fouled due to the deposit of impurities present in the fluid (generally river water, sea water or water coming from cooling towers or other sources).

In general, two collectors, one for feeding with the heat-transfer fluid and one for discharging the fluid respectively, are joined to each side of the enclosure and connect the latter to a heat-transfer fluid feed circuit. The balls are separated from the fluid after having passed through the discharge collector and then reinjected into the feed collector by means of a recycling device placed near the enclosure.

To illustrate this type of condenser, the reader may in particular refer to French patent application published under the number FR-A-2 438 815 or its United States equivalent bearing the number US-4 283 807.

Although this type of condenser is entirely

satisfactory from the standpoint of its operation, it does however pose space constraints, especially because of the arrangement of the ball-recycling device beneath the enclosure.

The object of the invention is in particular to solve this drawback by proposing a condenser which requires less space, and the installation of which is simplified.

For this purpose, the invention proposes a heat exchanger comprising:

- an enclosure provided with tubes in which a heat-transfer fluid circulates, said fluid conveying cleaning balls;
- an outlet collector connected on one side to said enclosure for discharging the heat-transfer fluid coming from said enclosure, and on the other side to a heat-transfer fluid discharge circuit, this collector being made as a single part; and
- a device placed in said collector for separating the cleaning balls from the fluid conveying them.

Since the balls are separated from the fluid in the immediate vicinity of the enclosure, directly in the collector, it is possible to save on long discharge pipes, and thus to guarantee a more compact installation. In particular, it is possible to place the exchanger in a lower position than is ordinary.

In this way, the heat exchanger may be located in places where the lack of space would force architects to choose a heat exchanger without cleaning means, to the detriment of good flow of the heat-transfer fluid and, in the end, of the quality of the cooling.

According to one embodiment, the outlet collector has a first portion forming a flow converger and a second portion forming a nozzle, which is joined to said flow

converger (for example a right-angled one) and in which the separation device is placed.

According to one embodiment, the separation device comprises a plurality of grids placed across said nozzle, combined in pairs in order to form a filtering structure with a W-shaped profile converging on the opposite side from said enclosure onto a device placed in the elbow in order to recover the cleaning balls separated from the heat-transfer fluid by the separation device.

Each grid comprises for example a row of spaced-apart parallel blades, preferably mounted on a common spindle extending across the nozzle of the collector.

Each grid may be mounted so as to rotate about its spindle, so as to allow it to clean properly.

In this case, the exchanger may include a device for measuring a fluid pressure difference on either side of the grids, said device being connected to a system designed to cause the grids to rotate when this pressure difference is greater than a predetermined value.

The exchanger may furthermore include a circuit for recycling the balls, which connects the device for recovering the balls to a feed collector joined to the enclosure in order to feed the latter with heat-transfer fluid, via which feed collector the balls are reinjected into the enclosure.

Other features and advantages of the invention will become apparent over the course of the following description of one of its embodiments, given by way of nonlimiting example and with reference to the appended drawings in which:

- figure 1 is a sectional side view of a condenser according to the invention;

- figure 2 is a sectional side view of a detail of figure 1, illustrating an elbowed discharge collector; and

- figure 3 is a perspective view, with partial cut away, illustrating the collector of figure 2.

Figure 1 shows a heat exchanger, also called a condenser, comprising an enclosure 1 provided with a plurality of tubes 2 in which a heat-transfer fluid (in this case, water) circulates in order to condense steam coming for example from a turbine of a power station (not shown).

The heat-transfer fluid is brought into the enclosure 1 via a feed collector 3 (also called a "water box") joined to the enclosure 1 via a first side wall 4, in which wall the tubes 2 terminate on that side where the fluid enters the enclosure 1 in order thereafter to flow into the tubes 2.

The fluid is discharged from the enclosure 1 by an outlet collector 5 (also called a "water box") joined to the enclosure 1 via a second side wall 6, opposite the first wall 4, the tubes 2 terminating in said second side wall 6 on that side where the fluid leaves the enclosure 1 after having flowed through the tubes 2 that constitute the place where heat exchange takes place between the heat-transfer fluid and the steam, the latter condensing on the external walls of the tubes 2 before flowing away to a collecting tank 7 located beneath the enclosure 1.

As can be seen in figure 1, the heat-transfer fluid conveys cleaning balls 8 made of an elastically compressible material, which balls, conveyed by the fluid, travel with the latter along the tubes 2.

The diameter of the balls 8 is greater than the inside diameter of the tubes 2 so that, by traveling along the

latter, the balls 8 scrap their internal walls, thus cleaning them of impurities which, transported by the heat-transfer fluid, build up thereon.

The tubes 2 extend parallel to one another along a horizontal axis X perpendicular to the side walls 4, 6, which in this case are vertical walls.

By convention, it is assumed that the heat-transfer fluid flows from the first side wall 4 to the second side wall 6 - i.e. in figure 1 from the left to the right, as indicated by the arrow F.

The outlet collector 5 has an upstream mouth 9 via which it is joined to the enclosure 1 and a downstream mouth 10 via which it is joined to a pipe (not shown) for discharging the heat-transfer fluid, the cross section of the upstream mouth 9 here being greater than that of the downstream mouth 10.

As is apparent in figure 3, the outlet collector 5 comprises, from the upstream end to the downstream end, a first portion 11 which forms a flow converger (in this case of rectangle cross section, although any other cross section is conceivable), and a second portion 12 of approximately constant (here circular) cross section joined to the flow converger 11 as a single part, the collector 5 thus forming a single piece.

According to one embodiment, illustrated in the figures, the flow converger 11 and the nozzle 12 form an approximately right-angled elbow so that the flow leaving the enclosure 1 horizontally is deflected downward, the nozzle 12 extending along an approximately vertical axis Y.

This arrangement, given by way of example, is in no way restrictive as its purpose is to channel the flow into

a recovery zone imposed by the configuration of the premises. Thus, the nozzle could extend along the X axis, or meet with the latter any angle between 0° and 90°.

As may be seen in figure 2, a device 13, designed to separate the balls 8 from the fluid conveying them, is placed in the outlet collector 5, and more precisely in the nozzle 12.

This device 13 comprises a plurality of grids 14, 15, 16, 17 placed transversely with respect to the vertical axis Y of the second portion 12 of the outlet collector 5, in this case close to the downstream mouth 10.

As may be seen in figure 3, each grid 14, 15, 16, 17 comprises a row of parallel blades 18, 19 held at an equal distance apart by means of a plurality of coaxial spacers 20, together forming a common spindle 21, 22, 23, 24 for supporting the respective grid 14, 15, 16, 17, which spindle extends across the nozzle 12 of the collector 5.

Each blade 18, 19 has an approximately straight leading edge 25, inclined to the direction of the flow, indicated in figure 2 by the arrow F', with an angle of between 15° and 30°.

Each blade 18, 19 also has an upstream end 26, 27 and a downstream end 28, 29 opposite one another.

As may be seen in figure 2, the grids 14, 15, 16, 17 are combined in pairs 14, 15 on the one hand and 16, 17 on the other, the spindles 21, 22, 23, 24 of the grids 14, 15, 16, 17 being parallel to each other in pairs.

Each grid 14, 15, 16, 17 is mounted so as to rotate about its respective support spindle 21, 22, 23, 24 between a normal operating position, illustrated by the

solid lines in figure 2, in which the grids 14, 15, 16, 17 of each pair 14, 15 and 16, 17 converge on the upstream end to the downstream end - i.e. on the same side as the downstream ends 27 - and a cleaning position, illustrated by the dotted lines in figure 2, in which the grids 14, 15, 16, 17 of each pair 14, 15 and 16, 17 on the contrary diverge, from the upstream end to the downstream end.

In one embodiment illustrated in figure 2, the separation device 13 comprises at least two pairs of grids 14, 15 on the one hand and 16, 17 on the other, each consisting of a central grid 15, 16 located near the Y axis of the second portion 12 of the outlet collector 5, and the blades 19 of which are relatively long, and of a periphery grid 14, 17, located near the wall of the collector 5, and the blades 18 of which are relatively shorter.

In the normal operating position, in which each blade 18, 19 presents its leading edge 25 to the flow, the central grids 15, 16 are back-to-back, the upstream ends 27 of their respective blades 19 being in contact pairwise with each other, whereas the periphery grids 14, 17 are in contact with the wall of the collector 5, the upstream ends 26 of their blades 19 bearing against the internal wall of the collector 5.

Thus, in the normal operating position, the grids 14, 15, 16, 17 together form a filtering structure with a W-shaped profile, each pair of grids 14, 15 and 16, 17 forming a funnel into which the balls 8 pass and defining, between the downstream ends 28 and 29 of their respective blades 18, 19, an interstice 30, 31.

The gap between two adjacent blades 18, 19 of any one grid 14, 15, 16, 17 is smaller than the diameter of the balls 8, so that a ball 8 cannot pass between two adjacent blades 18, 19.

However, the width of the interstice 30, 31 between the downstream ends 28, 29 of the blades 18, 19 of any one pair of grids 14, 15 or 16, 17 is greater than the diameter of the balls 8.

The balls, after having been guided by the leading edges 25 of the blades 18, 19, are therefore forced by the flow to pass into the interstice 30, 31. As there is no other passage in the cross section of the outlet collector 5 for the balls 8, they are thus separated from the fluid conveying them by the grids 14, 15, 16, 17.

As illustrated in figure 2, a device 32 is placed in the elbow 5 in order to recover the balls 8 leaving the separation device 13. This device 32 comprises two receptacles 33, 34, each placed in line with the interstice 30, 31 of each pair of grids 14, 15 and 16, 17, the balls 8 being received in said receptacles in order subsequently to be reused.

For this purpose, a ball-recycling circuit 35 is provided, which connects each receptacle 33, 34 of the recovery device 32 to the feed collector 3 via which the balls 8 are reinjected into the enclosure 1. A pump (not shown) placed in the recycling circuit 35 sucks out the balls 8 housed in the receptacles 33, 34 in order to send them back into the feed collector 3.

The impurities transported by the heat-transfer fluid are gradually deposited on the leading edge 25 of the blades 18, 19. To ensure that the blades 18, 19 are regularly cleaned, the grids 14, 15, 16, 17 are periodically rotated about their respective spindles 21, 22, 23, 24 so as to place them in the cleaning position (as illustrated by the dotted lines in figure 2), the flow thus traveling over the leading edge 25 in the opposite direction and detaching the

impurities that have built up thereon.

Progressive fouling of the blades 18 has the effect of gradually reducing the flow area for the fluid in the region of the grids 14, 15, 16, 17, and therefore of impeding its free flow. This results in a pressure difference in the fluid between the upstream end of the grids 14, 15, 16, 17 and the downstream end thereof. Above a certain threshold, this pressure difference may cause the grids 14, 15, 16, 17 to deform, or even to break.

It is therefore proposed to measure this pressure difference using suitable means and, when the pressure difference exceeds a predetermined threshold, considered to be critical for flow of the fluid, to cause - automatically by means of a suitable control system to which the probes are connected - the grids 14, 15, 16, 17 to rotate so as to allow them to be cleaned.

As the grids 14, 15, 16, 17 are placed not far from an elbowed region of the outlet of the enclosure 1, the flow of the fluid near the grids 14, 15, 16, 17, both at the upstream end and the downstream end thereof, is swirling, which makes a conventional pressure measurement difficult.

To overcome this difficulty, it is designed to measure the fluid pressure, upstream and downstream of the grids 14, 15, 16, 17, by means of probes placed in hollow protective tubes provided with perforations (with a diameter of between 3 mm and 10 mm). Thanks to these perforations, the fluid in the tubes is static, making a reliable pressure measurement possible. As we have just seen, the separation device 13 is particularly compact. Placed directly in the discharge collector 5 for the heat-transfer fluid, and more precisely in the nozzle 12 of said collector, it makes

it possible to reduce the overall size of the installation.

Moreover, the one-piece construction of the outlet collector allows it to be mounted more quickly and conveniently, and therefore provides a simplified installation of the condenser and its cleaning system.